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No. 1670

DESCRIPTION OF
THE FIRE COMMANDER'S PLOTTING BOARD

MODEL OF 1906

AND INSTRUCTIONS FOR
ASSEMBLAGE, ADJUSTMENT,
CARE, AND PRESERVATION

(*FOUR PLATES*)

FEBRUARY 14, 1908

WASHINGTON
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1917

DESCRIPTION OF FIRE COMMANDER'S PLOTTING BOARD AND INSTRUCTIONS FOR ASSEMBLAGE, ADJUSTMENT, CARE, AND PRESERVATION.

A fire commander's plotting board, when shipped from the Frankford Arsenal, is packed in a box containing, besides the board, necessary tools for use in mounting the board, and also a pair of adjustable trestles, disassembled. These trestles should be assembled before removing the board from the box.

After assembling the trestles and adjusting them to a suitable height the board should be removed from the box and mounted on them. The metal auxiliary supporting legs 3N should next be attached and adjusted to receive their due proportion of the weight.

The base plate 12N, to which is attached the gun center guides 12L, the pantograph 11A, 11B, 11C, 11D, and the templet 12A, should next be carefully removed from the packing box and assembled to the board. To do this, place the brass spacing washer in the hole located at 2. Care should be taken to see that the washer and the azimuth arm on which it rests are perfectly clean. Having inserted the brass spacing washer as above, next place the base plate over the center pivot. *In doing this be careful to keep the base plate parallel to the board until it is in place, as owing to its weight and the close fit of the center pivot in the hole it would injure the center pivot if inserted at an angle.* The clamping screw is then inserted through a slot in the azimuth arm and through the spacing washer and is screwed to the base plate 12N.

Next mount the gun center. See first that the guides are perfectly clean. Remove hexagon headed stud from under side of longitudinal slide and turn the movable limb 8C until the gun-arm box 9A will clear the guide bracket 12K. Hold the gun center with the dials toward the templet 12A and insert it carefully between the guides 12L, keeping it parallel both to the guides and to the board. When the gun center is in position turn the movable limb 8C until the gun-arm box 9B is under the guides 12L.

Now connect pantograph 11A, 11B, 11C, 11D with the longitudinal slide. To do this, place the gun center with the tapped hole in the longitudinal slide 11DA over the opening in the board 3, then move the pantograph until the hole in the short arm is in line with the tapped hole in slide 11DA. The hexagon headed stud can then be inserted, using end wrench, which will be found in small drawer.

All the pivots of the pantograph are ball-bearing pivots, as are also the rollers on the lateral slide. These were perfectly adjusted before leaving Frankford Arsenal and should not be disturbed. If after use it should become necessary to adjust these bearings, great care should be taken, as the balls, ball cones, and studs are very hard, and if too much strain is placed on the adjusting nut the balls may break. The adjusting nut on the pantograph pivots has a right-hand thread and is counterbored to admit a smaller nut with a left-hand thread, which locks the adjusting nut after the bearing is adjusted properly. Do not attempt to move the adjusting nut until after the locking nut has been released. These nuts have an arrow, showing in which direction *to release.* If it is desired to remove the pantograph attachment from the base plate, it is necesssary first to remove the gun-arm center from the guides, then the guide nearest the templet, and then the nuts from pivot stud. Next lift the arm from the base plate. To disassemble ball-bearing joints remove small pin at base of thread and then cone from stud, when the balls will drop out. Wrenches for adjustment will be found in small drawer.

The scale arms furnished with this board are:

1 steel primary arm, 4CI.
1 steel secondary arm, X5A.
1 German silver gun arm, 4N.
1 bronze auxiliary arm, X5J.

The primary arm is stamped "P," the secondary arm "S," and the auxiliary "A," with "R" or "L," according as the board is right or left handed.

Before mounting the scale arms be sure that the center pivot and the pivoting hole in the scale arms are perfectly clean. The primary arm 4CI is the first to be mounted. It is inserted over the center pivot and lies close to the board. The auxiliary arm X5J is next placed over the primary arm 4CI, the fiducial edges of both arms being on the same side. The secondary arm X5A is placed over the pivot of the movable center 6B and passes over the primary arm 4CI and is laid parallel to the auxiliary arm X5J. Now insert the keys in the undercut groove on the pivots.

The next step is to mount the index boxes on the arms. Mount the index box marked "*Prim. right*" or "*Prim. left*" on the primary arm 4CI. Mount the index box marked "*Aux. right*" or "*Aux. left*" on the auxiliary arm X5J. In mounting the index boxes first remove the lock plate on the under side of the box. Then place the dial pointer at "50" and insert the racks marked "A" and "B," according to their corresponding marks on the index boxes. Extreme care must be taken to have the tooth of the pinion marked

“O” mesh with the tooth of the rack marked “O.” Hold rack in position and place it over the proper arm and over the azimuth circle 4B. Replace the lock plate. If the rack has been inserted correctly, the index dial can be moved from “0” to “99.” In mounting the index boxes, see that the locking levers are on the outside of their respective arms.

Now, connect the secondary arm X5A to the auxiliary arm X5J by means of the coupler. This coupler is for the purpose of keeping the secondary arm X5A parallel to the auxiliary arm X5J, and is of the same length as the base line. This length, in yards, is stamped on the coupler. A small U-shaped clip is furnished, fitting in the undercut groove on the underside of the secondary arm X5A and over the coupler, retaining the latter in position.

On the outside of each index box on the lock plate will be noticed a small lip. When the edge of this lip is opposite the center of a notch in the azimuth circle, the locking lever can be pulled out, thus locking the index box and permitting an adjustment of ninety-nine one-hundredths ($\frac{99}{100}$) of a degree by the dial on the index box. Just above the lock plate of the index box will be noticed a small knob. Before attempting to turn the dial this knob must be pulled out. Its movement is about one-eighth of an inch. After obtaining the correct reading, push the knob in, thus locking the dial.

Before entering the gun arm 4N in the gun arm box 9B, see that the box is perfectly clean.* Then move the gun arm clamp 9Y all the way forward, set the range correction dial so that the graduation marked “*Enter arm*” coincides with the pointer. Next, enter the arm and set the dial at the reference number 2000. If the arm has been inserted correctly, the end of the beveled edge will be flush with the end of the gun arm box. The mounting of the board is now complete.

TO ORIENT THE BOARD.

First establish the normal line of the board. The normal line is the radius at right angles with the base line, when the azimuth vernier 3E is set at zero. In this connection it should be noted that the primary and secondary arms are set to read azimuth angles and not angles made by either arm with the base line. The center of the center notch in the azimuth circle 4B and the center of the primary pivot establish this normal. The base plate 12N, on which the base line scale is graduated, may be moved through one degree in either direction, and set to the proper reading by means of the azimuth vernier 3E, as follows: The zero of the base line must be given the degree number of the azimuth of the actual base line. It is convenient to give the right-hand zero of the base line the number of the nearest whole degree to the azimuth of the base line and the left-hand zero the number of the nearest whole degree to the back azimuth. For example, the azimuth of the base line being 211.°315, the nearest whole degree to the azimuth of the base line is 211°. This gives 121° as the whole degree of the normal and 31° as the whole degree of the back azimuth. Now, to complete the orientation of the base line to correspond to 211.°315, it is necessary to swing the base plate 12N counter-clockwise, through 0°.315. To do this, first release the clamping screw on the underside of the board. This is directly under the point 2. Set the vernier 3E to the proper reading and clamp rigidly.

To orient the azimuth dial pointer, place the stylus 11P in the hole marked "*Station F′*" on the templet 12A. This places the gun center directly over the primary pivot. Now place the primary arm on the normal line and lock index box. Extreme care must be taken to have the dial of the index box at zero in this adjustment. Next place the targe 5C against the primary arm and bring the gun arm against the targe. Remove the tally subdial 8H, thus exposing the clamping screw of the azimuth dial 8M. Release the clamping screw and adjust until the zero of 8M coincides with the pointer. If there is not enough adjustment in the slot, remove the pointer and change its position 90° or 180° on its square stem, and adjust anew, so that the pointer will come within the adjustment given. It is preferable to have the zero point toward the center of the board. Replace the subdial.

The gun azimuth circle should now be examined to see if it is numbered correctly. When the gun arm is against the targe, the stylus of the pantograph being inserted at *Station F′*, the adjustable reading edge of the gun azimuth window should be set coincident with a graduated line on the movable limb. The number corresponding to this line should be the same as the azimuth of the normal. The board is now ready for use.

TO USE THE BOARD.

The scale of this board is 300 yards to the inch. The pantograph arms are so constructed that when pivoted at 11S, the stylus 11P moves through a reversed space five times greater than that moved through by the end connected to the longitudinal slide 11DA. Hence, the scale of the templet is five times the scale of the board, or 60 yards to the inch. The holes in the templet 12A represent an accurate reversed plan of the centers of the observation stations, and directing guns of the various batteries. The names of these stations and batteries are marked directly under their respective holes. The hole marked "*Station F′*" represents the primary or central pivot of the board, the hole marked "*Station F″*" represents the secondary pivot.

If the pantograph arms are moved so that the stylus 11P can be placed in the hole marked "*Station F'*," the gun center will be exactly over the primary center of the board. As the line through *Stations F'* and *F''* on the templet is parallel to the base line, it is obvious that as the stylus is moved forward or backward, right or left, the gun center with the longitudinal slide 11DA will move reversely backward or forward, and the lateral slide 11AA will move reversely left or right, a distance one-fifth of that covered by the reversed corresponding motion of the stylus over the templet. Hence, if the stylus is inserted in any of the holes in the templet, it will place the gun center in a position exactly corresponding to the particular hole used, relative to the base line, and the range and azimuth as read to any plotted point will be the correct range and azimuth of that point from the station or directing gun designated by the marking of the hole in the templet occupied by the stylus. In this connection, note that moving the gun center to the various positions it may occupy does not change the orientation of the gun azimuth dial, as the movements to obtain the various positions are broken up into components parallel to and normal to the base line.

In making range corrections, the clamping lever 9Y should be released and the required adjustment made by moving the range dial 9U. The gun arm is at zero when the range dial pointer indicates the reference number 2000. After adjusting, tighten 9Y by pulling it in the direction indicated.

In making azimuth corrections, release the knurled clamping screw 8D on the azimuth correction plate 9T. By turning the azimuth correction worm 8G, the correct adjustment can be made. Read degrees directly from the azimuth correction plate, and one one-hundredths of degrees from the micrometer drawn on the right-hand end of the worm. After adjusting, screw down 8D.

The azimuth correction plate is at zero when the line on the worm cover coincides with the reference number 15. The micrometer drum should then be at "0." If the micrometer drum needs adjusting, release the clamping nut by the spanner wrench to be found in the drawer. Hold the micrometer down in position with small pin to be found in drawer and tighten the nut. If the worm works too freely in bearings, it may be adjusted by the set screw and nut on the left of the worm bracket. If the worm has any back lash, it may be taken up by releasing the two screws clamping the bracket to the movable limb 8C, and by setting the bracket closer to the azimuth correction plate 9T. Tighten the two screws again.

The small dial to the left of the gun azimuth dial is called the tally dial X11U, and in conjunction with the tally subdial 8H is used for obtaining angular travel of a target during a predicting interval. The hand scale 4D is a sliding scale, and is inserted in an undercut groove on the gun arm. It is used for obtaining change in range of a target during an observing interval.

Should the longitudinal slide become loose, due to wear, it may be adjusted by the adjusting wedge on the slide. To do this, first take out the hexagonal screw attaching the pantograph 11A, 11B, 11C, 11D to the longitudinal slide 11DA. Then by releasing the screw on the small end of the adjusting wedge, the screw on the large end may be adjusted until the slide can be moved freely, but without side play. The screw on the small end of the wedge is then tightened, thereby clamping the wedge. Should the lateral slide become loose and need adjustment, slightly release the screws fastening the adjustable roller support to the slide; release the nut on the inner side of the lug on the adjusting wedge, and adjust by turning the nut on the outer side of the lug. Each end of the slide should be adjusted separately, and the end that is being adjusted should be over guide bracket 12K. Great care should be taken not to spring the guides 12L while making this adjustment. It is imperative that the pantograph be disconnected from the longitudinal slide before attempting to adjust either slide, as each must be tested separately, and as there would be danger of bending the stylus end of the pantograph in moving the gun center, if either slide is made too tight.

DIRECTIONS FOR OILING.

As ease and accuracy of movement of the gun arm center and its connecting parts is essential in order to obtain accurate relocations, it is obvious that care and judgment must be used in its manipulation. Before attempting to move the stylus, the guides and all bearing surfaces should be wiped free from dust or grit and then oiled. Oil holes have been placed on all parts that can not be reached directly. These should be looked for. To oil the lateral slide, four oil holes are provided, two located on either side of the slide close to the guides, and marked "Oil." To oil the longitudinal slide rollers, an oil hole is located in the center of the stud and is marked "Oil." To oil the range correction pinion shaft, an oil hole is located on top of the range-correction knob. To oil the gun arm clamp sleeve, an oil hole is located on the range correction dial. To oil the movable limb pivot, two holes marked "Oil" are located directly under the range correction dial. To oil the azimuth correction worm 8G, oil is applied directly to the bearings. All joints of the pantograph arms and the pantograph pivot 11S have holes marked "Oil" in this center. To oil the screw connecting the pantograph to the slides, an oil hole is located in the center of the longitudinal slide close to the rim of the fixed limb 8B. To oil the azimuth dial bearings, remove the tally subdial 8H and oil where marked. An oil hole is also located on the periphery of the azimuth dial box.

To oil the tally dial X11U, remove the dial and disk and oil the pivot bearings. The dial bearing on the gun center will not require oiling more than two or three times a year. Oil holes are provided on top of the index boxes for oiling the bearing surface of the index disk latch. The surface of the clamping lever spring on the index boxes should be kept well oiled. The surface of the base plate where pantograph arms bear should be kept oiled and free from grit. The pivot bearings of the scale arms should be oiled occasionally. The best grade of clock oil only should be used on this instrument.

When the board is not in use, it should be kept covered with the canvas cover provided.

List of tools furnished for each fire commander's plotting board, Model of 1906.

1 screw driver, 10″.6 long, 7″.35 blade.
1 screw driver, 9″.4 long, 6″.15 blade.
1 wrench for nut of stud joining pantograph and longitudinal slide.
2 wrenches for roller pivot nuts.
2 wrenches for arm and pantograph pivot nuts.
1 pin wrench for micrometer head on azimuth correction worm.
worm, and for gun arm box nut.
1 pin wrench for micrometer head on azimuth correction worm.

NOMENCLATURE OF PARTS, WITH SYMBOLS REFERRING TO PLATES I, II, III, AND IV.

Symbol.	Name of part or position.
2	Position of base plate clamp.
3	Recess in board for assembling.
3E	Base line azimuth vernier and scale.
3N	Board supports.
4B	Azimuth circle.
4CI	Primary arm.
4D	Travel scale.
4N	Gun arm.
4Q	Base line scale.
X5A	Secondary arm.
5C	Targ.
X5D	Centerpiece for secondary arm.
X5F	Auxiliary centerpiece.
X5J	Auxiliary arm.
6A	Sliding station block.
6B	Adjustable pivot.
8B	Fixed limb.
8C	Movable limb.
8D	Azimuth correction plate clamp.
8G	Azimuth correction worm.
8H	Tally sub dial.
8M	Gun arm azimuth dial.
9B	Gun arm box.
9T	Azimuth correction plate.
9U	Range correction dial.

NOMENCLATURE OF PARTS, ETC.—continued.

Symbol.	Name of part or position.
9Y	Gun arm clamping lever.
11A	Pantograph arms.
11B	
11C	
11D	
11AA	Lateral slide.
11DA	Longitudinal slide.
11EA	Slide adjusting wedge.
11P	Stylus.
11S	Pantograph pivot.
X11U	Tally dial.
12A	Templet.
12K	Guide bracket.
12L	Guides.
12N	Base plate.
12P	Guard.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ORDNANCE,
Washington, February 14, 1908.

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12N-BASE PLATE
12A-TEMPLET
12L-GUIDES
11B-PANTOGRAPH
11AA-LATERAL SLIDE
11DA-LONGITUDINAL
8C-MOVABLE LIMB
8G AZIMUTH CORRE
9U RANGE CORRECT
9Y-9BA-GUN ARM CLAM
8D-AZIMUTH CORREC
9T-AZIMUTH CORREC
9A-GUN ARM BOX (S
4M-GUN ARM
X5B-SECONDARY AR
X5H-AUXILIARY AR
4DI-PRIMARY ARM
5C-TARG
11P-STYLUS
3E-12N-BASE LINE AZIM
6B-ADJUSTABLE PI
4Q-BASE LINE SCA
3-RECESS IN BOAR
11S-PANTOGRAPH PI
12K-GUIDE BRACKE
4B-AZIMUTH CIRC
8H-TALLY SUB DIA
8M-AZIMUTH DIAL
8B-FIXED LIMB
X11U-TALLY DIAL
4D-TRAVEL SCALE
2-POSITION OF BA
X8B-X8H-INDEX BOX
X8X-X8Y-LOCKING LEVE

0 2 4 6

PERTAINS TO		REVISIONS	
DET.	ON PLATE		

FIRE COMMANDER'S PLOTTING BOARD,
MODEL OF 1906.
GENERAL DRAWING.

FRANKFORD ARSENAL, U. S. A., JAN 15, 1908

G. H. Stewart

C.L.C. C.L.C.

CLASS 22 | DIVISION 20 | DRAWING 1 | FILE

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